

OPERATING EXPERIENCE WEEKLY SUMMARY

Office of Nuclear and Facility Safety

April 10 through April 16, 1998

Summary 98-15

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EVENTS

1. TEMPORARY STORAGE SHED POSES FIRE HAZARD AT LOS ALAMOS

On April 2, 1998, at the Los Alamos National Laboratory Chemistry and Metallurgy Research Facility, a fire protection engineer determined that a temporary storage shed used to stage legacy chemicals was not in compliance with National Fire Protection Association (NFPA)-80A requirements because it was located too close to the facility. Waste Management personnel placed the shed near the facility and staged the chemicals in it until they could be shipped to proper disposal locations. Investigators determined that no one performed a hazards assessment for this activity to determine if chemical storage requirements would be met. The facility manager suspended removal of legacy materials from the facility and directed facility personnel to remove the contents and relocate the shed to an acceptable location. Failure to properly implement the safety review process for this activity resulted in noncompliance with fire protection codes, created a potential fire hazard, and created a potential chemical safety hazard. (ORPS Report ALO-LA-LANL-CMR-1998-0012)

Investigators determined that in March 1998, the facility manager approved the removal of legacy chemicals from the facility. She believed that Waste Management personnel would locate the chemicals within the facility, identify them, and immediately ship them to proper disposal locations. After beginning the project, Waste Management personnel moved the storage shed near the facility loading dock and established it as a "less than 90-day waste accumulation area" to facilitate storage, characterization, and removal of the chemicals from the facility. Investigators determined that the facility manager was not informed of this action and had not approved use of the shed. On April 2, 1998, the facility manager became aware that Waste Management personnel had placed the shed and were storing chemicals and flammable materials in it. She requested that a fire protection engineer evaluate the location of the shed to determine if it was properly sited. The engineer determined that the shed was approximately 10 feet from the facility and was in violation of NFPA-80A, which required it to be placed a minimum of 37 feet from the facility.

The facility manager held a critique of the event. Critique attendees learned that using the storage shed constituted a new activity and that no one had reviewed the activity as required by facility safety review process procedures. Therefore, no one performed an unreviewed safety question determination or evaluated any potential hazards before erecting the shed. Waste Management personnel did not initiate the safety review process because they knew that the chemical removal activity was approved, and they did not consider the impact of a new waste accumulation area on potential fire or chemical hazard requirements. Attendees learned that the chemicals were originally stored in various locations throughout the facility and collecting them in one location could have resulted in incompatible chemicals being stored together. They also learned that using the shed for storage presented the potential for a variety of additional chemical hazards (such as storage in a non-climate-controlled environment, chemical degradation, or potentially explosive chemicals) in addition to the identified fire protection hazard. The facility manager directed the fire protection engineer to disseminate temporary structure placement information Laboratory-wide. She also suspended further removal of legacy chemicals from the facility until an unreviewed safety question determination is completed.

OEAF engineers reviewed the ORPS database and found one recent similar event. On March 17, 1998, at Rocky Flats Environmental Technology Site Plutonium Processing and Handling Facility, a facility manager reported that wooden low-level waste crates were stored outside of the facility and that no one had performed a safety analysis to evaluate the potential hazards. Fire protection personnel were concerned that a variety of storage requirements were not met, including those for (1) combustible loading, (2) minimum distances between crates, and (3) minimum distances between the crates and the facility. The facility manager directed facility personnel to perform an unreviewed safety question determination and relocate the crates to an acceptable location. (ORPS Report RFO--KHLL-779OPS-1998-0009)

These events underscore the importance of evaluating all hazards when removing hazardous legacy chemicals or waste from facilities. Managers of facilities that generate, receive, store, and ship chemicals must develop appropriate programs and procedures to identify all associated hazards. Facility managers should provide workers with the necessary information to ensure accurate and complete evaluations. Risks should be evaluated, and barriers should be put in place to reduce them. New activities and job scope changes need to be thoroughly reviewed, and the impact on the design and facility authorization bases should be evaluated. In this event, Waste Management personnel did not identify either the chemical hazards or the fire protection hazards. This event also illustrates the importance of ensuring that managers are informed of operations that may affect the facility. In this event, the facility manager should have been notified of the change in job scope so she could review and approve it. If the manager had been notified, she might have identified the problem before the job started.

Facility managers should review the following documents to ensure that practices and procedures are properly implemented and provided for in the facility authorization bases.

- DOE O 5480.19, *Conduct of Operations Requirements for DOE Facilities*, chapter II, "Shift Routines and Operating Practices," states that the on-duty shift supervisor should maintain authority and responsibility for all facility operations. Facility managers should also be informed of work that they are ultimately responsible for. Pre-job briefs or plan-of-the-day meetings should be held to communicate this information to the shift supervisors or facility managers in charge. Workers are not always aware of the ramifications that changes in work scopes can cause. Therefore, it is important that information concerning new activities and work scope changes be communicated to personnel who are in charge of operations.
- DOE O 5480.23, *Nuclear Safety Analysis Reports*, requires performing a hazard analysis to ensure comprehensive, integrated, and balanced risk management of all safety and environmental hazards. Section 3 requires analyses of expected releases, exposures, and accidents. It also requires consideration of residual risks to ensure that the risks and consequences of operation are acceptable and conform with safety design objectives.
- NFPA-80A, *Recommended Practice for Protection of Buildings from Exterior Fire Exposures*, provides recommendations to protect buildings from exterior fire hazards. It includes methods to determine necessary separation distances between buildings and potential ignition sources. NFPA codes and standards ordering information can be found on the NFPA Home Page located at URL <http://www.nfpa.org/>.
- The *Hazard and Barrier Analysis Guide*, developed by OEAF, discusses barriers that provide controls over hazards associated with a job. The guide provides a

detailed analysis for selecting optimum barriers, including a matrix that displays the effectiveness of different barriers in protecting against some common hazards. A copy of *The Hazard and Barrier Analysis Guide* is available at URL <http://tis.eh.doe.gov:80/web/oeaf/tools/hazbar.pdf>.

Information about chemical hazards can be found on the DOE Office of Environment, Safety and Health, Office of Worker Safety, Chemical Safety Program Home Page. The home page (located at URL http://tis-hq.eh.doe.gov/web/chem_safety/) provides links to many sources of information, including requirements and guidelines, lessons learned, chemical safety networking, and chemical safety tools.

KEYWORDS: fire protection, chemical, hazard analysis, work control

FUNCTIONAL AREAS: Hazards and Barrier Analysis, Work Planning, Fire Protection

2. SEVERE ARC OCCURS WHEN SOLVENT IS SPRAYED ON BREAKER BOX

On April 6, 1998, at the Oak Ridge East Tennessee Technology Park, a subcontractor decontamination worker sprayed solvent on an energized 440-volt breaker box causing a breaker fault and severe arcing. The decontamination worker was removing contamination from the exterior of the breaker box as part of a facility decontamination effort. Investigators determined that, when the solvent entered the breaker box, it caused a fault in the area of the lugs on top of the breaker and created an arc that burned a 1-inch by 6-inch hole in the front of the breaker box. The decontamination worker was not injured because he had left the area to allow the solvent to work. Other workers in the area observed the arcing and extinguished smoldering insulation with a portable fire extinguisher. The shift superintendent ordered facility personnel to apply a lockout/tagout to the affected circuit. Although the decontamination worker was not injured, there was potential for serious injury. (ORPS Report ORO--BJC-BJCETTP-1998-0001)

Investigators determined that the decontamination worker was using a garden-type pump sprayer to spray a non-flammable, water-based solvent. They also determined that he performed the work in accordance with approved project plans and with health and safety oversight provided by another subcontractor. Investigators also determined that work planners did not perform a hazard analysis addressing spraying cleaning solvent on live electrical switchgear.

This occurrence illustrates the importance of conducting thorough pre-job planning, including an activities hazard analysis of all anticipated work activities. Conducting a hazard analysis of spraying the breaker box with solvent would have shown that the breaker needed to be electrically isolated with a lockout/tagout or that a different method for applying the solvent should be used. As the DOE complex increases activities involving decontamination and decommissioning, using workers who are less skilled and unfamiliar with facility hazards, job planning will take on added significance because the potential for personal injury, contamination, and environmental release will also increase.

The following references provide guidance and good practices that should be used when planning decontamination and decommissioning work.

- Chapter 12 of DOE/EM-0142P, *Decommissioning Handbook*, March 1994, DOE Office of Environmental Management, provides requirements for worker protection

during decontamination and decommissioning activities. Although the handbook is not an active document (the Office of Environmental Management is revising it) it provides valuable guidelines that may be used until the revision is complete. The handbook states that worker protection is an important element of any project and divides worker protection issues into three categories: (1) protection from radiation; (2) protection from toxic and hazardous materials; and (3) protection from traditional industrial safety hazards. The handbook also states that DOE decommissioning activities may combine hazards not commonly encountered elsewhere (such as industrial safety hazards and radiological hazards) and lists OSHA regulations that apply to decommissioning, as well as key elements of a health and safety program. Section 12 of the handbook states that extra precautions are required for worker safety because hazards in the facility may be unknown and many activities are infrequently performed.

- The *Hazard and Barrier Analysis Guide*, developed by OEAF, discusses barriers that control job-associated hazards, such as physical barriers, procedural or administrative barriers, or human action. The reliability of a barrier is determined by its ability to resist failure. Barriers can be imposed in series to provide defense-in-depth and to increase the margin of safety. The guide includes a hazard-barrier matrix that shows that lockout/tagout is the most effective barrier against injury. When implemented properly, lockout/tagout provides a high probability (greater than 99 percent) of success for risk reduction. The guide provides a detailed analysis for selecting optimum barriers, including a matrix that displays the effectiveness of different barriers in protecting against some common hazards.

A copy of *The Hazard and Barrier Analysis Guide* is available from I-Ling Chow, (301) 903-5984. A copy may also be obtained by contacting the ES&H Information Center, (800) 473-4375, or by writing to U.S. Department of Energy, ES&H Information Center, EH-72, 19901 Germantown Road, Germantown, MD 20874.

KEYWORDS: breaker, decontamination & decommissioning, electrical safety, hazard analysis, work planning

FUNCTIONAL AREAS: Decontamination and Decommissioning, Work Planning

3. CONTAMINATED WATER TREATMENT CYLINDERS SHIPPED OFF-SITE

On April 8, 1998, at the Idaho National Engineering and Environmental Laboratory Specific Manufacturing Capability Facility, the facility manager reported that in March 1997, shippers sent a set of water treatment cylinders that potentially were internally contaminated to an off-site company for regeneration. Investigators determined that workers periodically remove the cylinder sets for regeneration from a system that cleans depleted uranium production material. They believe the cylinders were contaminated because facility personnel detected contaminated resin beads inside cylinders that were removed from service in November 1997. The facility manager suspended further cylinder shipments and requested further sampling to better understand if, and to what extent, internal contamination existed in the earlier off-site cylinder shipment. This event is significant because it resulted in a loss of control of radioactive material and could have caused a spread of contamination. (ORPS Report ID--LITC-SMC-1998-0003)

In April 1998, while preparing to ship the cylinders removed in November 1997, facility personnel found internal contamination and assumed that the cylinders sent off-site earlier in the year might also contain similar internal contamination. Laboratory radiological control technicians surveyed the off-site facility and found no detectable radioactive contamination.

Investigators determined that radiological control technicians had surveyed all cylinders for external contamination in preparation for shipment. They also determined that the work order for the November 1997, cylinder removal required radiological personnel to perform an internal survey of the cylinders before removing them from a radiological buffer area. They determined that radiological personnel drained these cylinders, surveyed them, and detected the presence of internal contamination. This led them to question whether earlier shipments had also been contaminated. Facility personnel who removed the set of cylinders shipped in March 1997, used a work order that did not stipulate that internal sampling must occur before the cylinders were removed from the radiological buffer area.

NFS reported the shipment of contaminated equipment to off-site facilities in several weekly summaries. Following are some examples.

- Weekly Summary 97-43 reported that shippers at the Los Alamos National Laboratory Accelerator Complex sent seven vacuum pumps to an off-site company for maintenance; three of the pumps were internally contaminated with up to 6 μCi per liter of tritium. Investigators determined that shippers removed the pumps from a controlled area and shipped them off-site without proper controls and labeling. A team of Los Alamos and DOE evaluators visited the off-site maintenance facility and took smear samples that indicated there was no spread of contamination to the employees, their tools, or the workplace. (ORPS Report ALO-LA-LANL-ACCCOMPLEX-1997-0014)
- Weekly Summary 94-25 reported that Sandia National Laboratory personnel sent sample material containing depleted uranium to an off-site contract laboratory without a radiological survey of the sample. Health Physics personnel surveyed the sample when it was returned to the facility and measured beta/gamma radiation levels of 1.2 mr/hr on contact and 0.02 mr/hr (background) at 3 feet. Site personnel indicated that the sample was not checked for radioactivity before shipping and was not labeled as containing radioactive material. (ORPS Report ALO-KO-SNL-7000-1994-0006)

These events illustrate the potential consequences of an informal attitude toward control of radioactive material and shipping. Each event resulted in an evolution that could have caused radiation exposures to workers and the spread of contamination. Radioactive material that has been surveyed for release should be properly tagged or labeled. Personnel who need to remove radioactive material from controlled areas should contact radiological protection personnel for release surveys and authorization. Radiological protection personnel should review DOE/EH-0256T, *U.S. Department of Energy Radiological Control Manual*. The manual provides clear direction on the marking, monitoring, and control of radioactive materials. Chapter 4, part 1, "Radioactive Material Identification, Storage, and Control," and Chapter 4, part 2, "Release and Transportation of Radioactive Material," provides the following guidance for labeling radioactive material, for its release from controlled and uncontrolled areas, and for transporting it off-site.

- Section 411, "Requirements," states that any equipment or system component removed from a process that may have had contact with radioactive material should

be considered contaminated until disassembled to the extent required to perform an adequate survey, surveyed, and shown to be free of contamination.

- Section 412, "Radioactive Material Labeling," states that radioactive material outside contamination, high contamination, or airborne radioactivity areas shall be labeled in accordance with Table 4-1 of the manual. Equipment, components and other items with actual or potential internal contamination should be labeled "CAUTION, INTERNAL CONTAMINATION" or "CAUTION, POTENTIAL INTERNAL CONTAMINATION." Labels should include contact radiation levels, removable surface contamination levels (specified as alpha or beta-gamma), dates surveyed, surveyor's name, and description of items. Items that are too small to be labeled with all of the stated information should be labeled, at a minimum, with the words "CAUTION RADIOACTIVE MATERIAL" and the standard radiation symbol.
- Section 422, "Release to Uncontrolled Areas," states that material in controlled areas or radioactive material areas, documented to have been released from contamination, high contamination, or airborne radioactivity areas, shall be surveyed before release to uncontrolled areas.
- Section 423, "Transportation of Radioactive Material," states that off-site shipments of radioactive material, including subcontractors' handling of off-site shipments, shall be controlled and conducted in accordance with the Radiological Control Manual and applicable Federal, state and local regulations.

KEYWORDS: radioactive material, internal contamination, labeling, shipping

FUNCTIONAL AREAS: Radiation Protection, Procedures

PRICE-ANDERSON AMENDMENTS ACT (PAAA) INFORMATION

1. PRELIMINARY NOTICE OF VIOLATION FOR CRITICALITY SAFETY INFRACTIONS AND RADIOLOGICAL WORK CONTROL VIOLATIONS

On March 26, 1998, the DOE Office of Enforcement and Investigation issued a Preliminary Notice of Violation under the Price-Anderson Amendments Act to Fluor Daniel Hanford Company for nuclear criticality safety infractions and radiological work control violations. The Notice proposes a \$140,625 fine against Fluor Daniel Hanford for violations that occurred between November 1996 and June 1997, and for an explosion that occurred in May 1997, at the Plutonium Finishing Plant. The Office of Enforcement and Investigation and the DOE Richland Operations Office conducted the investigation. Investigators were concerned that the criticality safety procedural violations, conduct of operations deficiencies, and explosion-related violations represented contractor problems in establishing and implementing safety standards and in ensuring that operations were conducted in accordance with procedures. Investigators also believe that the contractor missed opportunities to identify procedural adherence weaknesses and take effective corrective actions in some cases. The criticality safety deficiencies resulted in fissile material movement restrictions; the explosion resulted in substantial facility damage. (NTS-RL--PHMC-PFP-1997-0001; NTS-RL--PHMC-PFP-1997-0002; NTS-RL--PHMC-PHMC GENL-1997-0002; Letter, DOE (P.Brush) to Fluor Daniel Hanford Company (H. Hatch), 3/26/98; and DOE/RL-97-59, Rev. 0, "Accident Investigation Board Report on the May 14, 1997, Chemical

Explosion at the Plutonium Reclamation Facility, Hanford Site, Richland, Washington," 7/26/97)

The Office of Enforcement and Investigation staff identified multiple deficiencies and classified them as Severity Level II violations in the Preliminary Notice of Violation. Severity Level II violations are significant violations that demonstrate a lack of attention or carelessness toward safety that could potentially lead to adverse impacts. Investigators determined that these deficiencies represent potential violations of 10 CFR 830.120, "Quality Assurance Rule." The Notice describes (1) criticality safety procedure and posting limit violations and (2) several work control failures that occurred before, or in response to, the tank explosion.

CRITICALITY SAFETY VIOLATIONS

Investigators determined that facility managers failed to take appropriate corrective actions for the identified violations when workers informed them of the conditions and that the Quality Improvement Processes failed to identify and correct these violations in a timely manner through required monthly and semi-annual inspections. Investigators identified multiple, recurring examples of the following violations. They proposed a civil penalty of \$37,500 for each category listed.

- improper storage and transportation of plutonium material in a fixed array wagon
- failure to know and comply with glovebox criticality limits and postings
- failure to identify and correct criticality safety infractions

WORK CONTROL VIOLATIONS

Investigators determined that the following work control failures were of concern because of their widespread existence and continuing nature. They proposed a collective civil penalty of \$28,125 for the following violations.

- failure to perform emergency breathing apparatus device surveillances in accordance with the required frequencies
- failure to make proper and timely notifications of an emergency condition
- failure to perform proper radiological surveys before releasing personnel from the site
- failure of personnel to take cover when a "take-cover" condition was in place

In addition, investigators determined that substantial degradation of defense-in-depth occurred following the explosion when (1) the facility confinement barrier was compromised and (2) facility personnel did not correctly follow emergency response procedures during implementation of the emergency plan. Investigators determined that either of these deficiencies, by itself, was safety significant. They also determined that the tank explosion event demonstrated the unreliability of other barriers in place to prevent these types of events.

In July 1997, DOE issued DOE/RL-97-59, Rev. O, "Accident Investigation Board Report on the May 14, 1997, Chemical Explosion at the Plutonium Reclamation Facility, Hanford Site, Richland, Washington." This report concluded that (1) standby planning failed to maintain the facility in a safe condition, (2) management oversight did not ensure that the facility was maintained within the

safety authorization documentation during transition from operations to standby/shutdown, (3) line management did not adequately implement lessons learned from previous events, (4) line management did not incorporate safety authorization documentation hazard information into training and qualification processes for technical and operations staff, and (5) facility personnel did not document spontaneous reaction conditions or thoroughly understand the roles of temperature and catalysts involved in spontaneous reactions. These conclusions led to the development of several judgements of need. Fluor Daniel Hanford is to ensure that the following judgements of need are addressed.

- long-term shutdown procedures are adequate and implemented
- only safety authorization documentation activities are conducted
- corporate management standby planning procedures are adequate and implemented by line management
- lessons learned are effectively developed, identified, and addressed

The accident investigation report also lists the barriers that were in place, their purpose, and why they failed. In most cases the barriers failed because (1) lessons learned were not developed or implemented or (2) procedures were inadequate, not used by personnel, or violated. The report concluded that if any one barrier (physical, management, or administrative) had been properly implemented it could have prevented the explosion event.

Investigators considered reducing the proposed civil penalties. However, they determined that a reduction was not warranted for the proposed criticality safety violations because corrective actions were neither timely nor adequate. They also considered reducing the proposed civil penalty for the proposed explosion-related violations. They determined that a 25 percent mitigation of the base civil penalty was appropriate because the site demonstrated comprehensive analysis and implementation of corrective actions to the site-wide Emergency Response Plan during an event involving picric acid. However, they determined that full mitigation was not appropriate because deficiencies in the Emergency Response Plan were known before the explosion, but were not fully corrected.

Fluor Daniel Hanford management has 30 days to reply to the Preliminary Notice of Violation and admit or deny the alleged violations. The Preliminary Notice of Violation will become final if they admit the allegations and provide sufficient corrective actions within the 30-day period. Enforcement actions can be found at the Office of Enforcement and Investigation web site at URL <http://tis-nt.eh.doe.gov/enforce/>.

NFS reported issuance of Notices of Violations under the Price-Anderson Amendments Act in Weekly Summaries 98-11, 97-52, 97-41, 97-29, 97-12, 97-02, 97-01, 96-43, and 96-30.

Under the provisions of the Price-Anderson Amendments Act, DOE can fine contractors for violations of Department rules, regulations, and compliance orders relating to nuclear safety requirements. DOE contractors who operate nuclear facilities and fail to implement corrective actions for identified deficiencies could be subjected to Price-Anderson civil penalties under the work processes and quality improvement provisions of 10 CFR 830.120, *Quality Assurance Requirements*. These actions include Notices of Violation and, where appropriate, non-reimbursable civil penalties.

The primary consideration for determining whether DOE takes enforcement action is the actual or

potential safety significance of the violation, coupled with how quickly the contractor acts to identify and correct problems. The Office of Enforcement and Investigation may reduce penalties when a DOE contractor promptly identifies a violation, reports it to DOE, and undertakes timely corrective action. DOE has discretion to not issue a Notice of Violation in certain cases.

The Noncompliance Tracking System (Weekly Summaries 95-17 and 95-20) provides a means for contractors to promptly report potential noncompliances and take advantage of provisions in the enforcement policy. DOE STD-7501-95, *Development of DOE Lessons Learned Programs*, discusses management responsibility for incorporating appropriate corrective actions in a timely manner.

KEYWORDS: radiation protection, enforcement, Price-Anderson Act

FUNCTIONAL AREAS: Radiation Protection, Nuclear/Criticality Safety, Lessons Learned

FINAL REPORT

This section of the OE Weekly Summary discusses events filed as final reports in the ORPS. These events contain new or additional lessons learned that may be of interest to personnel within the DOE complex.

1. ISOKENETIC RADIATION MONITOR FAILS SOURCE CHECK

On January 10, 1998, at the Savannah River Site In Tank Precipitation Facility, operations and maintenance personnel observed that an isokenetic sampler used to monitor purge exhaust radiation levels on radioactive waste storage tanks failed a weekly source check. Facility managers entered a limiting condition for operation and established alternate radiation monitoring while instrumentation personnel performed troubleshooting. Investigators determined that trending of performance monitoring data collected during previous weekly source checks could have been used to identify the need to recalibrate the isokinetic sampler before it could no longer perform its function. (ORPS Report SR--WSRC-ITP-1998-0002)

Investigators plotted the actual responses of the isokinetic sampler recorded during seven source checks performed from December 6, 1997, to January 10, 1998. The plot showed that the response had been steadily decaying and finally fell below the allowable lower tolerance. The facility manager determined that the root cause of the failure was that no one plotted or analyzed data collected from the weekly source checks. Analysis of the data could have been used to determine if the sampler needed to be recalibrated before it could no longer perform its function. Corrective actions included implementing guidance contained in Westinghouse Savannah River Company Manual E7, *Conduct of Engineering and Technical Support*, procedure 3.04, "System Performance Monitoring." The manual discusses responsibilities and guidance for identification, testing, collection, and analysis of performance data for systems or components to improve reliability and availability through early detection of system and component degradation.

NFS reported on predictive maintenance issues in Weekly Summary 96-16. This issue discussed predictive maintenance practices used at commercial nuclear plants to increase reliability and extend component life. Maintenance departments at many commercial nuclear plants use predictive maintenance techniques to determine when preventive maintenance should be scheduled. Industry specialists have discovered that increased use of predictive maintenance

techniques can improve the reliability and availability of key components while reducing overall maintenance costs. (*The Nuclear Professional*, Winter 1996)

OEAF engineers searched the ORPS database for other occurrences where facility managers identified inadequate predictive maintenance practices contributing to system or component failure. Following are some examples.

- On March 14, 1997, at Hanford, maintenance workers discovered that one of the starting batteries for a diesel generator was dead. Investigators determined that the subcontractor mechanic did not chart the slowly diminishing specific gravity of the battery. If the contractor had charted this information, the battery could have been replaced before failure. (ORPS Report RL--BHI-DND-1997-0007)
- On February 15, 1991, at Hanford, operators observed smoke coming from an exhaust fan. Investigators determined that a combination of poor preventive maintenance and no predictive maintenance left the motor subject to premature wear and early failure. Facility managers implemented corrective actions that included improved data collection and analysis. (ORPS Report (RL--WHC-TANKFARM-1991-0140)

This event underscores the importance of collecting and analyzing system and component performance data. Trending data collected during surveillances or maintenance may help predict when components or systems can no longer reliably perform their intended function. In cases where predictive maintenance is suitable, increased system or component availability, as well as increased safety to workers, may be achieved. Examples of predictive maintenance tools include trending the results of source checks and data collected by thermal sensing, vibration analysis, and lubricating oil analysis.

The following references provide guidance maintenance planning organizations should use when developing predictive maintenance programs.

- DOE 4330.4A, *Maintenance Management Program*, section 8.1, states: "Management-directed and -delegated involvement in control of maintenance activities should ensure that maintenance practices are effective in maintaining safe and reliable facility operation." Pages II-18 and II-19 state that "operations maintenance surveillance, inspections . . . should be considered as essential source data in establishing the scope of the predictive and preventive maintenance program."
- DOE-STD-1051-93, *Guideline to Good Practices for Maintenance Organization and Administration at DOE Nuclear Facilities*, gives examples of good maintenance practices, including predictive maintenance, developed from commercial and DOE sources.
- DOE-STD-1052-93, *Guideline to Good Practices for Types of Maintenance Activities at DOE Nuclear Facilities*, provides guidance on selection of predictive maintenance components and techniques. Section 3.4.4.1 of this standard states, "Predictive maintenance should be integrated into the overall preventive maintenance program so that 'just-in-time' planned maintenance may be performed prior to equipment failure. Not all equipment conditions and failure modes can be monitored; therefore, predictive maintenance should be selectively applied." The standard describes several predictive techniques that may be used to detect equipment degradation before failure.

- DOE-STD-1068-94, *Guideline to Good Practices for Maintenance History at DOE Nuclear Facilities*, provides maintenance organizations with information that may be used for the development and implementation of maintenance information management systems and provides critical parameters essential to conduct effective maintenance planning, data trending, problem analysis, and to make maintenance management decisions based on maintenance history.

Reprints of the predictive maintenance article from *The Nuclear Professional*, Winter 1996, may be obtained by contacting Christine Crow at (301) 540-2396 or by email at Christine.Crow@eh.doe.gov.

KEYWORDS: maintenance, predictive maintenance, surveillance

FUNCTIONAL AREAS: Electrical Maintenance, Mechanical Maintenance, Surveillance